A
Project Report
on

"Self-reliant solar irrigation system"

Submitted By

Mr.Prathmesh Tukaram Kadam(2019BTEEN00055)
Mr.Sudhir Vasant Pawar (2019BTEEN00062)
Mr.Hansraj Umesh Sahani (2019BTEEN00064)
Mr.Ninad Nilesh Joshi (2019BTEEN00078)
Mr.Aashish Rajendra Revankar(2019BTEEN00087)

Under the guidance of

Dr.(Mrs.)A.A.Agashe

Department of Electronics Engineering

WALCHAND COLLEGE OF ENGINEERING, SANGLI
(Government-Aided Autonomous Institute)

2022-2023

WALCHAND COLLEGE OF ENGINEERING, SANGLI

(Government-Aided Autonomous Institute)

DEPARTMENT OF ELECTRONICS ENGINEERING

CERTIFICATE

This is to certify that the Project Report entitled

‘***Self-reliant solar irrigation system*** ’

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Mr.Prathmesh Tukaram Kadam(2019BTEEN00055)
Mr.Sudhir Vasant Pawar (2019BTEEN00062)
Mr.Hansraj Umesh Sahani (2019BTEEN00064)
Mr.Ninad Nilesh Joshi (2019BTEEN00078)
Mr.Aashish Rajendra Revankar(2019BTEEN00087)

in partial fulfilment for the award of the Degree of

Bachelor of Technology

in

Electronics Engineering

is a record of students own work carried out by them under our supervision and guidance during the academic year 2022-2023

Date:29/05/2023
Place: Sangli

Dr.(Mrs.)A.A.Agashe
(Project Guide)

Dr.S.D.Ruikar
(HOD)

Abstract

This report describes a self-sustaining solar irrigation system that utilizes solar energy as its power source. The system incorporates an automated irrigation system driven by a solar tracker. The solar tracker utilizes an LDR sensor, while the irrigation system relies on sensors for soil moisture, temperature, and humidity. The overall system is controlled by a Node MCU microcontroller, which enables automation. Additionally, an administrative user can remotely monitor the irrigation system through the Blynk IoT app.

The primary objective of the microcontroller is to interface with the subsystems and make informed decisions to ensure the system operates efficiently. The system operates by harnessing solar energy from solar panels and storing it in a battery, enabling continuous operation.

To achieve optimal performance, a set of rules has been developed to guide the system's operation. This system adopts eco-friendly energy sources with high efficiency. Moreover, the system is designed to be robust, allowing for easy scalability based on the energy requirements.

Acknowledgement

We would like to express our gratitude to our project guide, ***Dr. (Mrs.) A. A. Agashe*** for her comprehensive guidance, enthusiastic encouragement, and efficient tips for this project. We would also like to thank ***Dr. S. D. Ruikar*** and ***Dr. S. G. Tamhankar*** for their rigid support and valuable constructive suggestions throughout the process. Essentially, we would like to thank our college ***Walchand College of Engineering, Sangli*** and ***Electronics Engineering Department*** for giving us the resources and laboratory for implementing our project.

Mr. Prathmesh Kadam
(2019BTEEN00055)

Mr. Sudhir Pawar
(2019BTEEN00062)

Mr. Hansraj Sahani
(2019BTEEN00064)

Mr. Ninad Joshi
(2019BTEEN00078)

Mr. Aashish Revankar
(2019BTEEN00087)

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Chapter 1

Introduction

A) Smart Irrigation:

Smart irrigation is a term used to describe the application of advanced technologies and data-driven methods to optimize water usage in agricultural and landscaping irrigation systems. This approach involves the integration of various components such as sensors, weather data, and automation techniques to enable more efficient and targeted irrigation practices.

The utilization of smart irrigation technologies provides several advantages, including water conservation, cost savings, and enhanced plant health. By incorporating data-driven approaches and automation, these systems facilitate precise and efficient water management, thereby promoting sustainable practices in agriculture and landscaping.

B) Solar Energy:

Solar energy is derived from the radiant energy emitted by the Sun and can be converted into electricity or heat for various applications. It is considered a renewable and plentiful source of energy with several advantages.

One of the key benefits of solar energy is its environmental friendliness. Solar power generation produces no greenhouse gas emissions or air pollutants, contributing to cleaner air and reduced carbon footprint. By harnessing solar energy, we can reduce our reliance on fossil fuels and help mitigate climate change.

In summary, solar energy presents a sustainable and eco-friendly alternative to traditional energy sources, providing clean power generation without depleting natural resources or contributing to environmental pollution

C) Solar tracker:

A solar tracking system is a mechanism that orients solar panels or solar collectors to follow the movement of the sun throughout the day, optimizing their exposure to sunlight. The purpose of a solar tracking system is to maximize the energy output of solar panels by ensuring they are perpendicular to the sun's rays, thus capturing the maximum amount of solar energy.

- **Project Idea:**

The problem definition is that we need to design a system which will make efficient use of the energy provided to it using solar. This innovative system aims to achieve self-sufficiency by utilizing a solar tracker to provide energy for powering the smart irrigation system.

The primary goal of the project is to develop an irrigation system that optimizes water usage and reduces energy dependency. By integrating a solar tracker, the system harnesses solar energy efficiently, ensuring a sustainable and eco-friendly power source. The solar tracker's ability to automatically orient itself toward the sun maximizes energy generation and minimizes reliance on traditional energy grids.

Furthermore, the smart irrigation system component of the project incorporates advanced technologies such as soil moisture sensors, weather data integration, and automated watering schedules. This intelligent system monitors and analyzes environmental factors in real-time to determine precise irrigation requirements. By leveraging data-driven insights, it ensures optimal water distribution, reducing water waste and enhancing crop yields.

By combining solar energy utilization with intelligent irrigation techniques, the Self-Reliant Smart Irrigation System seeks to create a sustainable and self-sufficient solution for agricultural needs. This project aligns with the growing demand for environmentally friendly practices and demonstrates the potential of innovative technologies in the field of agriculture.

- ## Proposed Work:

❖ Objectives:

i. To reduce the dependency on traditional way of irrigation and irrigating the crop by monitoring the soil moisture content.

ii. To use renewable source of energy, in this project solar energy, so as to power the smart irrigation project.

iii. Making crop virtually accessible from any part of the world by designing a mobile app and hosting data on the web.

iv. To make agriculture smarter, faster, and efficient.

❖ Methodology:

i. First, we divide the project into small sub-parts such as power circuit, solarcircuit, smart irrigation system.

ii. We find the existing ways or technologies for designing these small parts andwill try to learn from the existing projects.

iii. We try to modify the existing system for better performance and better feasibility.

iv. We find out the cost of required materials and try to collect them from themarket and college labs.

v. After finalizing the circuit of individual small parts, and designing each sub-system, we combine all of them to the whole system.

vi. We implement the system on hardware and evaluate the performance.

❖ Expected Outcomes:

i. Solar tracker circuit should move as per the position of sun to maximize energy output.

ii. The energy delivered must be sufficient to power up the smart irrigation system.

iii. All the important parameters such as soil moisture, humidity, and temperature critical for the agriculture must be visible on the mobile app.

Chapter 2

Literature Survey

1) "Efficiency Improvement of Solar Panels Using Dual-Axis Solar Tracker System" by S. K. Srivastava, R. K. Mishra, and S. N. Sinha
Published in: International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering
Year: 2018
Summary: The paper describes the implementation of a solar tracking system using Arduino microcontroller. It provides a step-by-step guide on the hardware setup, software programming, and algorithm development for tracking the sun's position. System's performance is evaluated through experimental results.

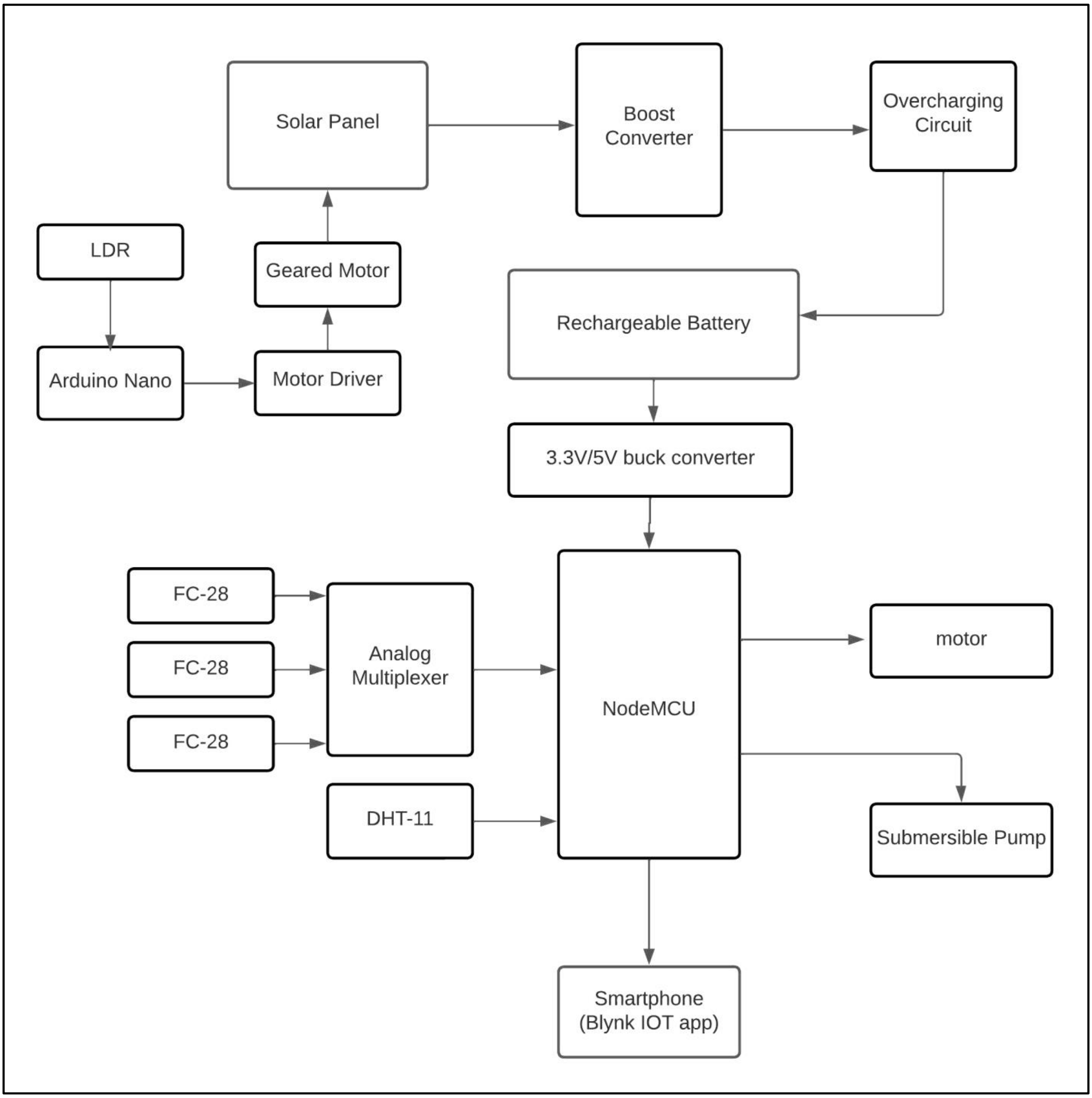
2) "Comparison of Single-Axis and Dual-Axis Solar Tracking Systems in Tropical Regions" by H. A. Yulianto, S. H. Wibowo, and R. J. Priyono
Published in: International Journal of Electrical, Electronics and Data Communication
Year: 2019
Summary: This research work focuses on the efficiency improvement of solar panels through integration of a dual-axis solar tracker system. It presents a detailed analysis of the system's design, control mechanism, and experimental evaluation of energy generation improvement.

3) "Smart Irrigation Systems for Agricultural Applications: A Review" by H. P. Thaduri and M. Chitti Babu
Published in: International Journal of Engineering Research and Technology
Year: 2019
Summary: This review paper focuses on smart irrigation systems specifically for agricultural applications. It discusses the integration of sensors, controllers, and communication technologies in smart irrigation systems and their impact on water conservation and crop productivity. The study also addresses the challenges and potential solutions for implementing smart irrigation in agriculture.

4) "A Review on Smart Irrigation Control Techniques" by M. B. Shams, H. Khaliq, and A. Javaid
Published in: International Journal of Advanced Computer Science and Applications
Year: 2016
Summary: This review paper explores different smart irrigation control techniques, including soil moisture-based irrigation, weather-based irrigation, and evapotranspiration-based irrigation. It discusses the advantages, limitations, and technological aspects of these techniques, providing insights into the design and implementation of smart irrigation systems.

Chapter 3

Design of System



Brief explanation of the block diagram –

The system block diagram can be broken down to 2 major parts – Solar tracker and IoT irrigation.

Solar tracker comprises of solar panel, 2 LDR sensor, 2 geared motors, Arduino Nano, motor driver, boost converter, rechargeable batteries, and an overcharging circuit.

Purpose of this part is to maximize the solar energy output by moving to the direction of sun. Difference in the sensitivity value of LDR is driving force of our solar tracker. It will give feedback to our system regarding the position of sun. Panels will be rotated using 2 DC geared motor.

Gear motor were used because in this system we needed high output torque and lower rotational speed of output shaft, as we have limited space and available power.

The solar panel which we used was not of sufficient voltage to recharge the battery hence we used a boost converter to increase the output from solar panel.

But once battery is completely recharged, we need to stop the flow of current to safeguard the battery. Hence, we designed an overcharging circuit. It was built from LM324 OP-AMP.

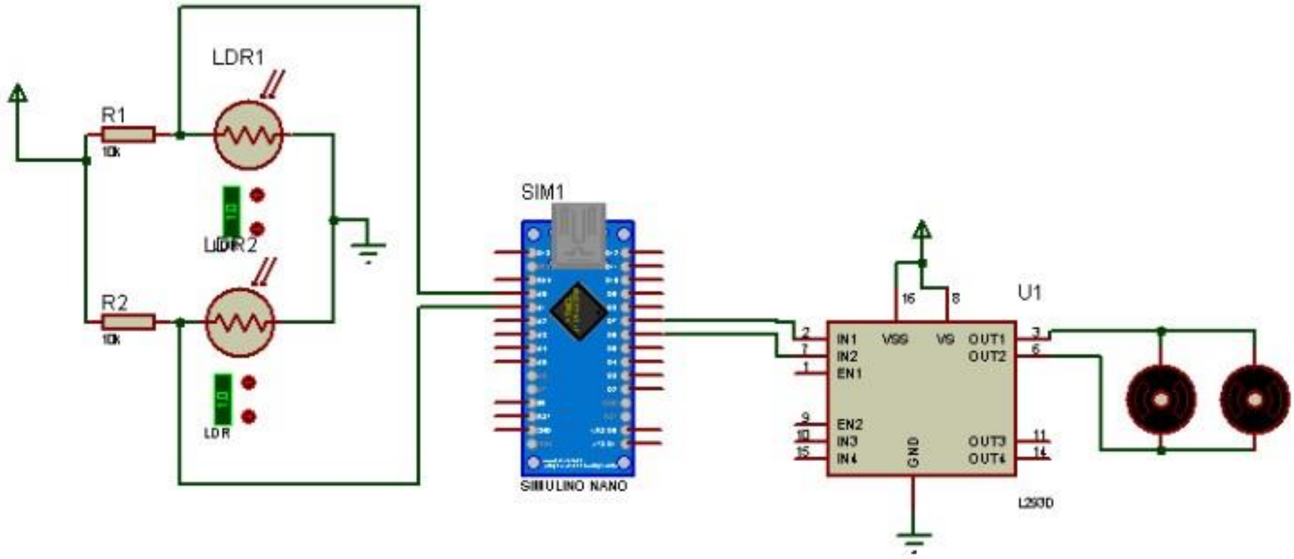
This rechargeable battery is now responsible for powering entire system, i.e., Rotating the solar panels using geared motors and supplying the power to NodeMCU to make our IoT irrigation system functional.

IoT irrigation part consists of NodeMCU, 3 FC-28 (soil moisture) sensors, DHT-11 (Temperature & Humidity) sensor, 16 channel analog multiplexer, pump, motor, Blynk IoT app (can be used as mobile application as well as web app on desktop).

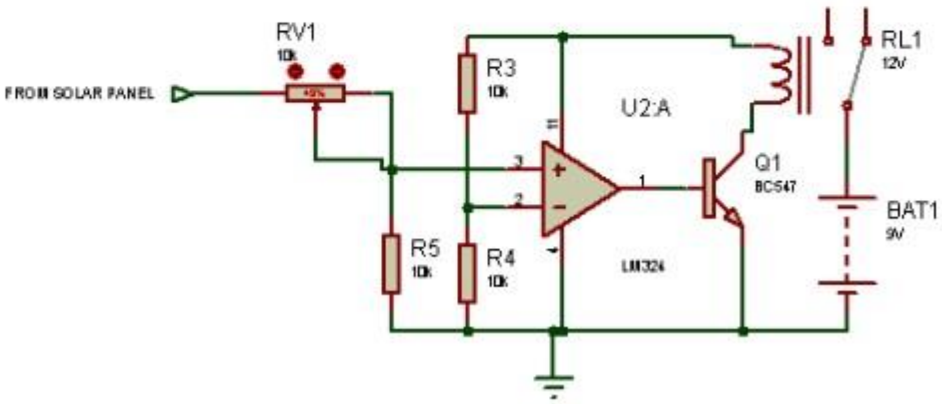
Soil moisture sensors are analog sensors, which are connected to analog mux as NodeMCU has only one analog pin. All the sensor values are collected and sent to our MCU. Simultaneously all the sensor values are updated in real-time and can be monitored using Blynk IoT app.

Once the soil moisture of a certain plant is below the recommended value, motor adjusts itself in that direction and then pump is powered on to irrigate the soil. As soon as the soil moisture reaches the max. limit it stops and similar process continues for other plants.

Circuit Diagram –



Circuit Diagram- Movement of solar panel



Circuit Diagram- Overcharging Circuit

Description of Components:

- **Solar Panel –**

Fig. Solar Panel

A solar panel, also known as a solar cell panel, solar electric panel, or photo-voltaic module (PV), is a framework-mounted assembly of photo-voltaic cells designed for installation. These panels utilize sunlight as an energy source to produce direct current electricity.

❖ Node MCU ESP8266 –

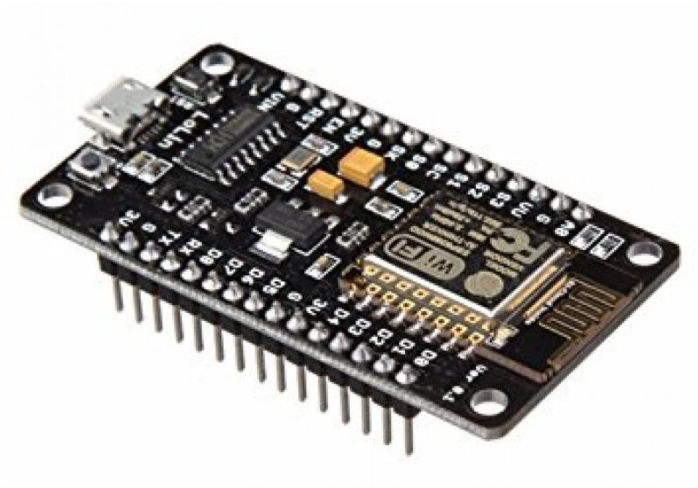


Fig. Node MCU ESP8266

1. Microcontroller: The microcontroller used is the Tensilica 32-bit RISC CPU Xtensa LX106.
2. Operating Voltage: The operating voltage is 3.3V.
3. Input Voltage: The input voltage range is specified as 7-12V.
4. Digital I/O Pins (DIO): It has a total of 16 digital input/output pins.
5. Analog Input Pins (ADC): It features 1 analog input pin.
6. UARTs: The microcontroller includes 1 UART interface.
7. SPIs: It supports 1 SPI interface.
8. I2Cs: It has 1 I2C interface.
9. Flash Memory: The module is equipped with 4 MB of flash memory.
10. SRAM: It has a built-in SRAM capacity of 64 KB.
11. Clock Speed: The microcontroller operates at a clock speed of 80 MHz.
12. USB-TTL: It includes an onboard USB-TTL converter based on CP2102, allowing for easy plug-and-play functionality.
13. PCB Antenna: The module is designed with a PCB antenna.
14. Compact Size: The module is designed to fit efficiently within IoT projects.

Pin Category	Name	Description
Power	Micro-USB, 3.3V, GND, Vin	**Micro-USB:** NodeMCU can be powered through the USB port **3.3V:** Regulated 3.3V can be supplied to this pin to power the board **GND:** Ground pins **Vin:** External Power Supply
Control Pins	**EN, RST**	The pin and the button resets the microcontroller
Analog Pin	A0	Used to measure analog voltage in the range of 0-3.3V
GPIO Pins	GPIO1 to GPIO16	NodeMCU has 16 general purpose input-output pins on its board
SPI Pins	SD1, CMD, SD0, CLK	NodeMCU has four pins available for SPI communication.
UART Pins	TXD0, RXD0, TXD2, RXD2	NodeMCU has two UART interfaces, UART0 (RXD0 & TXD0) and UART1 (RXD1 & TXD1). UART1 is used to upload the firmware/program.
I2C Pins		NodeMCU has I2C functionality support but due to the internal functionality of these pins, you have to find which pin is I2C.

❖ Soil moisture Sensor:

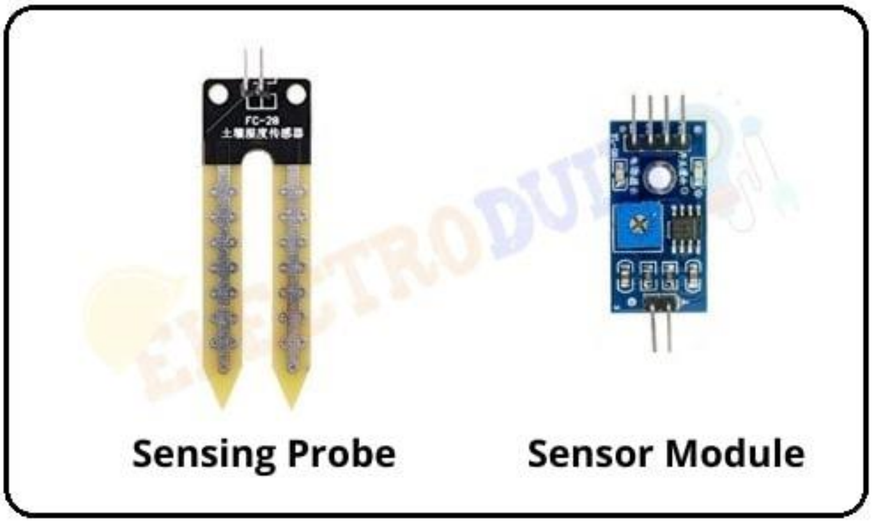


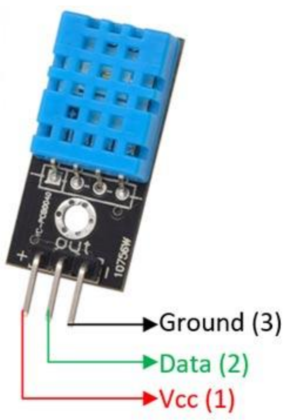
Fig. Soil moisture Sensor

Pin Number	Pin Name	Description
1	**VCC**	+5 v power supply
2	**GND**	Ground (-) power supply
3	**DO**	Digital Output (0 or 1)
4	**AO**	Analog Output (range 0 to 1023)

Features:

- Operating Voltage: The sensor operates within the range of 3.3V to 5V DC.
- Operating Current: It requires a current of approximately 15mA during operation.
- Output Digital: The digital output voltage ranges from 0V to 5V and can be adjusted based on the preset trigger level.
- Output Analog: The analog output voltage ranges from 0V to 5V, depending on the infrared radiation received from a fire flame falling on the sensor.
- LED Indicators: The sensor includes LEDs to indicate the output status and power status.
- LM393 Based Design: The sensor's design is based on the LM393 integrated circuit.
- Compatibility: It is user-friendly and can be easily used with microcontrollers or standard digital/analog integrated circuits.
- Small, Affordable, and Easily Accessible: The sensor is compact in size, cost-effective, and readily available in the market.

❖ DHT 11 sensor:



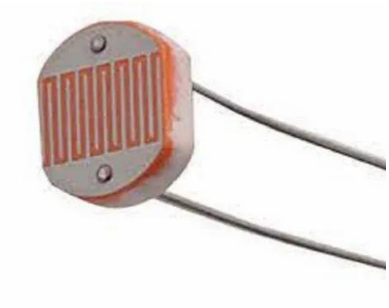
For DHT11 Sensor module		
1	Vcc	Power supply 3.5V to 5.5V
2	Data	Outputs both Temperature and Humidity through serial Data
3	Ground	Connected to the ground of the circuit

Pin Connection of DHT11

Features:

• Operating Voltage: The sensor operates within the range of 3.5V to 5.5V.
• Operating Current: During measurement, the sensor consumes approximately 0.3mA, while in stand by mode, it consumes about 60uA.
• Output: The sensor provides serial data as output.
• Temperature Range: It can measure temperatures ranging from 0°C to 50°C.
• Humidity Range: The sensor can measure humidity levels from 20% to 90%.
• Resolution: Both temperature and humidity measurements have a resolution of 16 bits.
• Accuracy: The sensor offers an accuracy of ±1°C for temperature measurements and ±1% for humidity measurements.

❖ LDR sensor:



Features:

• At 0 lux (no light), the sensor can handle a maximum voltage of 200V.
• The sensor has a peak wavelength sensitivity of 600nm.
• sensor exhibits a minimum resistance of 1.8kΩ when exposed to 10 lux of light.
• The sensor can have a maximum resistance of 4.5kΩ under 10 lux illumination.
• Under 100 lux illumination, the sensor typically shows a resistance of 0.7kΩ.
• The sensor's resistance after being in complete darkness for 1 second is approximately 0.03MΩ.
• sensor's resistance after being in complete darkness for 5 seconds is approximately 0.25MΩ.

❖ Submersible Pump

This mini submersible water pump, designed for DC operation, is particularly suitable for various applications, including small vending machines and scenarios where a small volume of water needs to be pumped.

It operates within a voltage range of 3 to 12V and can be easily controlled using development boards such as Arduino, Raspberry Pi, ESP, and other microcontrollers.

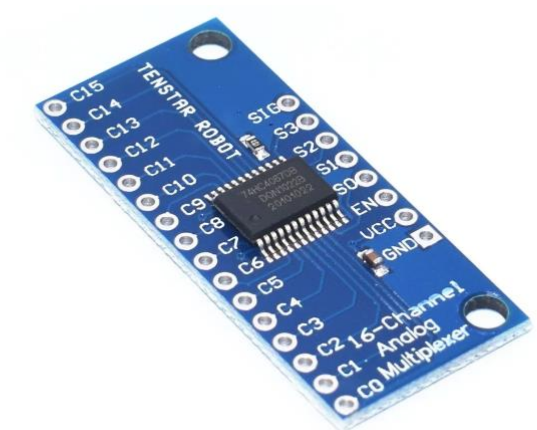
As a result, it is commonly utilized in DIY electronics projects and hobby projects. The pump is capable of achieving a pumping height ranging from 40 to 110 cm, and it features a 6 mm water outlet.

❖ L293D motor driver

Features:

- The motor controller supports a supply voltage range of 4.5V to 12V.
- Each motor can draw a maximum current of 600 mA.
- The controller is equipped with male burg-stick connectors for easy and secure connections to the power supply, ground, and input signals.
- The motor connections are facilitated through screw terminal connectors, simplifying the process.
- The inputs of the motor controller are designed with high noise immunity, ensuring reliable operation even in noisy environments.

❖ CD74HC4067CMOS analog multiplexer:



Features:

• This breakout board functions as a 16-channel analog/digital multiplexer/demultiplexer.
• It operates within a voltage range of 2V to 6V (VCC).
• The "On" resistance is approximately 70 Ohms when operating at 4.5V.
• The breakout board ensures a break-before-make timing of 6ns at 4.5V, preventing any overlap during switching.
• It has a wide operating temperature range from -55°C to 125°C.

❖ DC geared motor:

Fig. 12V Geared Motor

Features:

• The motor operates at an operating voltage of 12V DC.
• It has a shaft diameter of 6mm with an internal hole.
• The motor provides a torque of 2 kg-cm.
• The maximum no-load current drawn by the motor is 60 mA.

❖ Buck convertor:

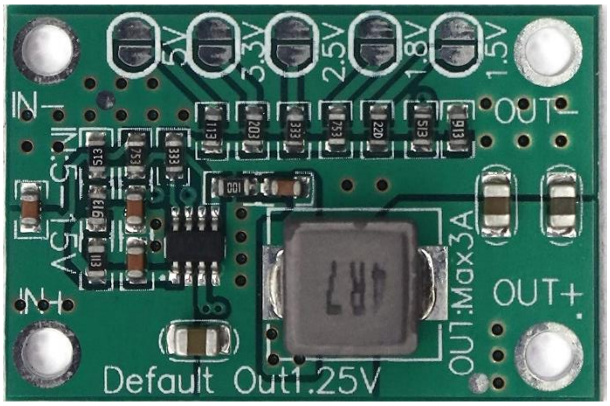
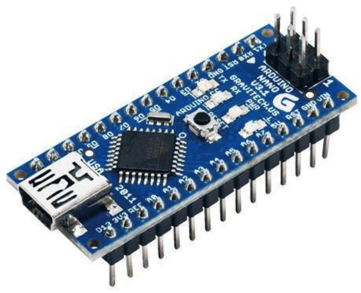


Fig. Buck (Step-down) Converter

Features:

1. Input Voltage: 4.5V – 28V
2. Output Voltage: 0.8V – 20V
3. Output Voltage Adjustment: On-board potentiometer
4. Output Current: 1.8A (typical), 3.0A (max).
5. Ceramic Capacitor Stable
6. Internal Soft-Start
7. Internally Set Current Limit without a Current Sensing Resistor

❖ Arduino nano:



Features:

- The microcontroller used is the Microchip ATmega328P.
- The operating voltage for the microcontroller is 5 volts.
- The microcontroller can accept input voltages in the range of 5 to 20 volts.
- It has a total of 14 digital input/output pins, with 6 of them optionally supporting PWM outputs.
- The microcontroller features 8 analog input pins.
- Each I/O pin can provide a DC current of up to 40 mA.
- The 3.3V pin can supply a DC current of up to 50 mA.

❖ 12v Relay:

Features:

- Maximum Current: The relay can handle a maximum current of 5A, whether it is alternating current (AC) or direct current (DC).
- Maximum Voltage: The relay is rated for a maximum voltage of 250V AC or 30V DC.
- Nominal Voltage: The nominal voltage for the relay is specified as 12V.
- Coil Resistance: The coil of the relay has a resistance of 270Ω.
- Coil Current: The coil current required for the relay is approximately 44.4mA.
- Operating Voltage: The relay operates within an operating voltage range of 8.6V to 21.6V.

❖ LM324N Op-Amp:

Features:

- Internally Frequency Compensated for Unity Gain
- Offers a large DC voltage gain of 100 dB
- Wide bandwidth of 1 MHz at unity gain, with temperature compensation
- Operates over a wide power supply range:
    - Single supply voltage range: 3V to 32V
    - Dual supply voltage range: ±1.5V to ±16V
- Features very low supply current drain of 700 µA

❖ CA 6009 Dc to DC module:

Features:

- The module has an adjustable output voltage ranging from 5V to 35V.
- It offers a load regulation of 0.5%, ensuring stable output voltage even with varying loads.
- The voltage regulation is also 0.5%, providing consistent output voltage despite input voltage fluctuations.
- An adjustable potentiometer is available onboard for convenient adjustment of the output voltage.
- The module accepts input voltages in the range of 3V to 32V.

❖ 3.7V Rechargable battery:

Features :

•	Battery Capacity	1200mAh
•	Size	18*65mm
•	Cycles	More than 600 times cycles
•	Weight	0.4g Approx
•	Power	3.7V

Chapter 4

Hardware Implementation

We have divided our project into two parts, one is smart irrigation system and other one is solar tracker system.

- **Smart Irrigation system –**

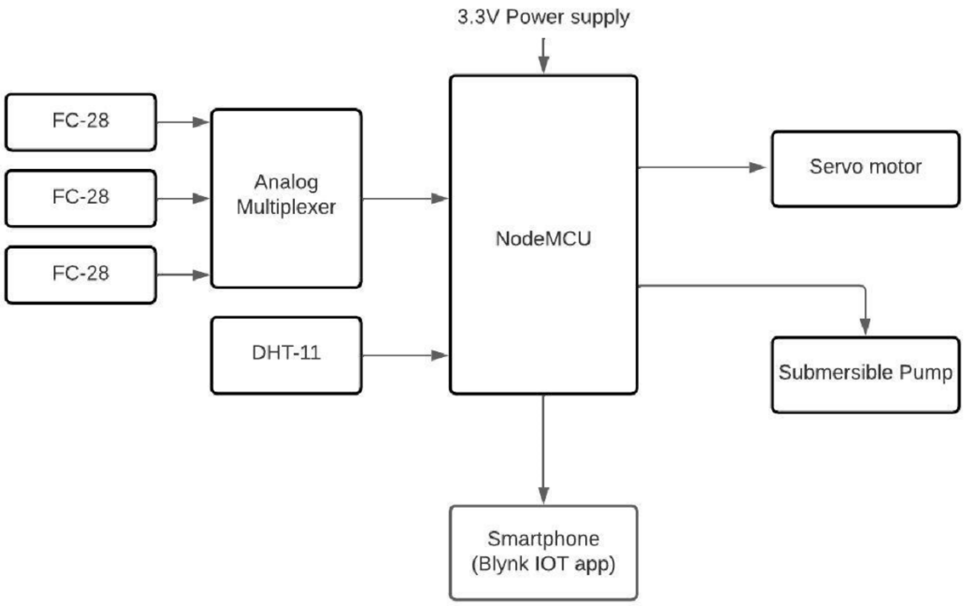


Fig. Smart Irrigation system

– Here FC-28 is the soil moisture sensor which we are using to measure the moisture level of the soil.

– As node MCU has only one analog input pin and the output from the soil moisture sensor will be analog therefore we have used Analog multiplexer.

– We have used DHT-11 temperature and humidity sensor to measure the temperature and humidity of the surrounding.

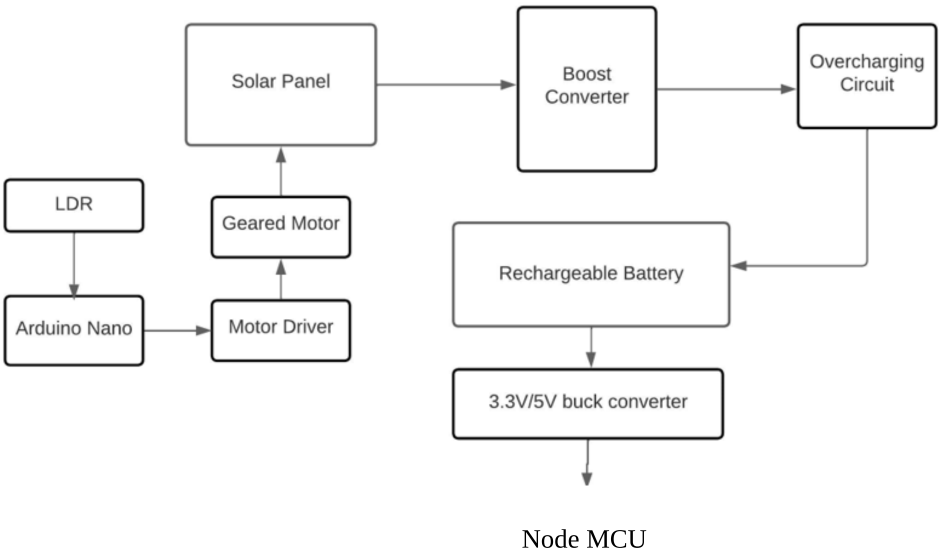
– If the moisture level of the soil is less than the threshold percentage then the submersible pump will start its operation.

– Servomotor is used to rotate the pipe in the direction where the watering is needed.

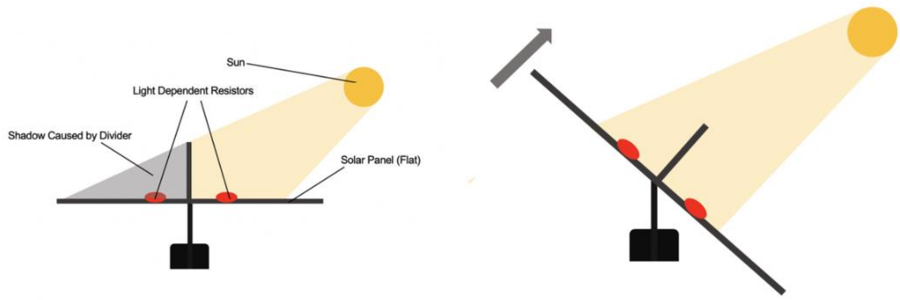
– We have used Blynk IOT app to monitor the condition of the soil and environment virtually.

– The power supply to Node MCU will be provided by the second part which is solar tracker.

- **Solar Tracker system:**

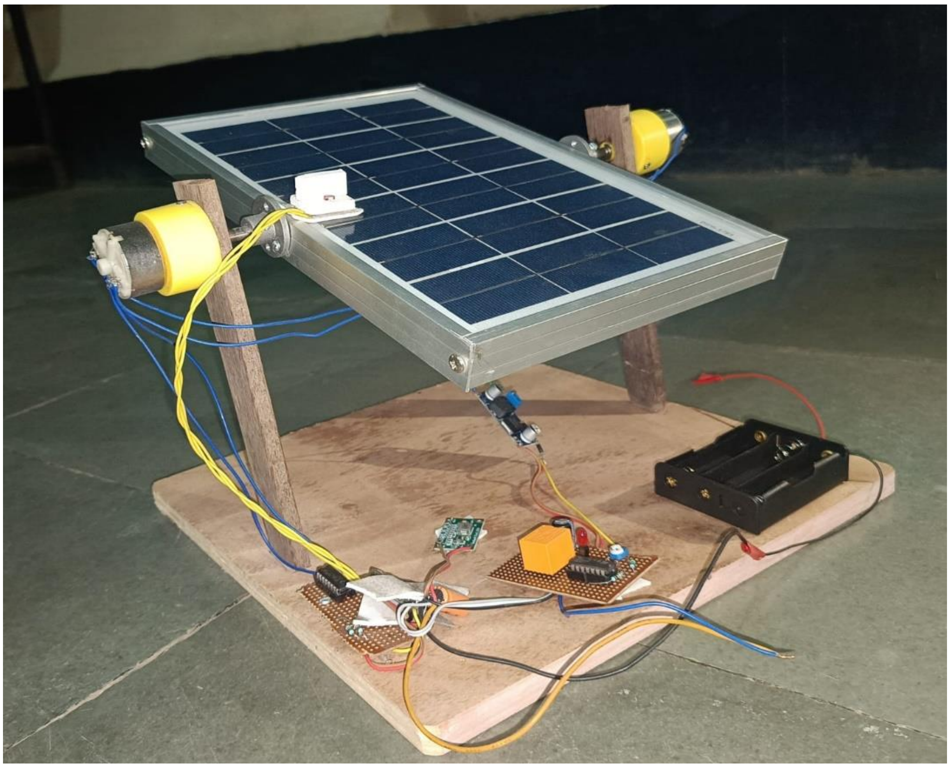


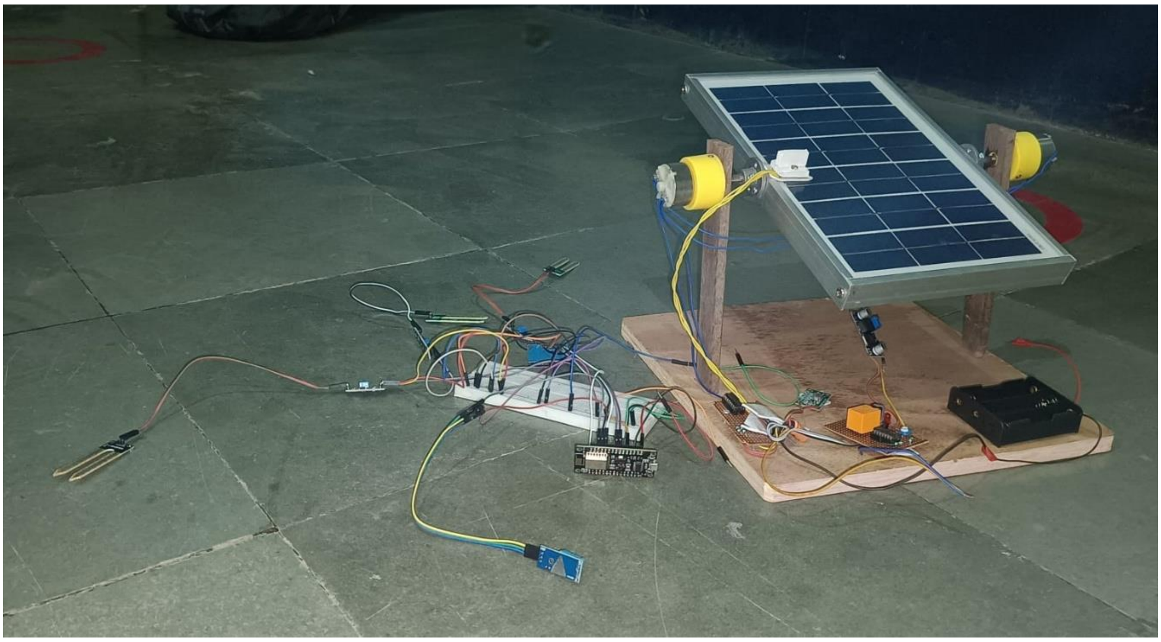
- We have used LDR sensor in order to detect the intensity of the light.
- The reason for using two LDR sensors is we have used partition between them and that partition will result in shadowing one of the LDR and because of that the light intensity will not be same at both the LDR as shown in the below fig.



- Now that information will be provided to the Arduino nano.
- Now the Arduino will rotate the solar panel with the help of geared DC motor such that both the LDR will have the same intensity of the light.
- We have also used overcharging circuit in order to protect battery from overcharging when it reaches its maximum voltage limit.
- As solar panel generates electricity, the charged controller or overcharging circuit ensures that the battery is not continuously charged beyond its safe operating voltage.
- We have used boost converter to efficiently increase the voltage level of the solar panel output to a higher voltage that is suitable for charging battery.
- Solar panels typically generate lower voltages than what is required to charge a battery. The boost converters steps up the voltage while regulating the current to ensure efficient charging.
- We have used Buck converter to lower the voltage in order to power up the microcontroller.

- **Practical Circuit –**





Chapter 5

Results And Discussion

We are pleased to announce the successful completion of our project, the Self-Reliant Smart Irrigation System. After extensive research, design, and implementation, we have achieved the desired objectives and developed a functional system that integrates solar energy tracking, soil moisture sensing, and remote monitoring through a mobile app.

The key results of our project include:

Solar Tracker System: We have successfully implemented a solar tracker system that optimizes the solar energy output. By tracking the movement of the sun, the system adjusts the position of the solar panels, maximizing their exposure to sunlight and increasing energy efficiency.

Soil Moisture Sensing: Our system incorporates soil moisture sensors that accurately detect the moisture levels in the soil. This information allows for precise and targeted irrigation, ensuring that plants receive water only when necessary, reducing water waste, and promoting optimal plant health.

Blynk App Integration: We have integrated the Blynk app into our system, providing users with a user-friendly interface for monitoring and controlling the irrigation system. The app displays real-time moisture levels of different areas, enabling users to make informed decisions about irrigation and water management.

Improved Water Efficiency: Through the integration of solar energy tracking and soil moisture sensing, our system optimizes water usage and irrigation efficiency. By delivering water only to areas with low moisture levels, we minimize water waste and contribute to sustainable water management practices.

Based on the successful completion and functionality of our project, we declare that our Self-Reliant Smart Irrigation System is ready for deployment and practical implementation in various applications, including agriculture, landscaping, and smart gardening.

Chapter 6

Conclusion And Future Scope

In conclusion, our self-reliant smart irrigation system incorporating a solar tracker system, soil moisture sensors, and a Blynk app has the potential to significantly improve irrigation efficiency and promote sustainable water usage. By harnessing solar energy and utilizing real-time soil moisture data, the system ensures that plants receive water only when necessary, reducing water waste and optimizing plant health.

The integration of the Blynk app allows for convenient monitoring and control of the system, providing users with valuable insights into soil moisture levels and enabling them to make informed irrigation decisions. Overall, our project offers an innovative and environmentally friendly solution for efficient irrigation management.

Future Scope:

1) Automated Watering Schedule:

Developing an algorithm that considers plant-specific water requirements, growth stages, and environmental factors can automate the irrigation schedule. This would eliminate the need for manual intervention, making the system even more self-reliant.

2) Data Analytics and Optimization:

Collecting and analyzing historical data on soil moisture levels, solar energy generation, and irrigation patterns can provide insights for optimizing the irrigation system. Machine learning algorithms can be employed to identify patterns, correlations, and trends, allowing for continuous improvement and better water management.

3) Integration with IoT Ecosystem:

Integrating the smart irrigation system with other IoT devices and platforms can enhance its functionality. For example, connecting it to a weather station, water flow sensors, or automated valve controllers can create a comprehensive smart farming or landscaping ecosystem.

4) Mobile App Enhancements:

The mobile app can be further enhanced with features such as push notifications, historical data visualization, and the ability to remotely adjust irrigation settings. These additions would provide users with more control and insights into their irrigation system.

Chapter 7

References

A) Research papers:

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[3] Micro-Controller-Based-Automatic-Plant-Irrigation-System.pdf (ijoart.org) - Venkata Naga, Rohit Gunturi, “Micro Controller Based Automatic Plant Irrigation System”, International Journal of Advancements in Research & Technology, Volume 2, Issue4, April-2013.

B)Websites:

[1] https://en.wikipedia.org/wiki/Soil_moisture_sensor
[2] http://wiki.sunfounder.cc/index.php?title=Humiture_Sensor_Module
[3] https://www.geeetech.com/wiki/index.php/One-Channel_Relay_module
[4] https://www.electronicshub.org/getting-started-with-nodemcu/
[5] Soil Moisture Sensor | How it’s Works » ElectroDuino
[6] https://www.sciencedirect.com/topics/engineering/solar-tracking-system
[7] ESP8266 NodeMcu Pinout – ESP8266 Shop (esp8266-shop.com)
[8] business-standard.com/article/economy-policy/solar-irrigation-india
[9] Quartz components website

Appendix - A

Data sheets

1. **Node MCU ESP8266 -**
   https://www.alldatasheet.com/datasheet-pdf/pdf/1148030/ESPRESSIF/ESP8266EX.html

2. **LM324N-**
   https://www.alldatasheet.com/datasheet-pdf/pdf/17880/PHILIPS/LM324N.html

3. **CD74HC4067-**
   https://www.alldatasheet.com/datasheet-pdf/pdf/27059/TI/CD74HC4067.html

Appendix - B

Plagiarism Report